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SOME RESULTS OF THE SOUTH POLAR CAMPAIGN.

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IN March of last year, in an article in this REVIEW, I gave a sketch of the actual state of the various forces that were then besieging the still-uncaptured fastnesses entrenched within the thick-ribbed ice of the North and South Polar areas. During the short period that has since elapsed, much has happened, at least in connection with the international forces that have been laying siege to the Antarctic. Preliminary reports of the results of the German and Swedish expeditions have been published, while the British and Scottish national expeditions under Captain R. F. Scott and Mr. Bruce, respectively, have returned. From these latter, reports are also available which enable us to form a very fair estimate of the results which have been achieved in the various departments of science in which investigations were carried out. In a general way, to continue the metaphor with which we started, it may be said that positions of the first importance have been captured, and the way has been opened to science to secure the mastery over the last remaining outpost of ignorance on the face of the globe. We can now form a fair idea of the configuration of the vast area of land which surrounds the South Pole; while in geology, meteorology, terrestrial magnetism, oceanography and biology, the spoils have been immense.

The geographical results are probably those which will appeal most to the general reader. A map of the Antarctic, as it was in 1904 before these expeditions sailed, will show in the region to the south of New Zealand, between 71 degrees and 78 degrees south latitude, and between 160 degrees and 170 degrees east longitude, a block of mountainous land, apparently isolated, terminating in the south in Mounts Erebus and Terror. This was, practically, as Sir James Ross left it sixty years ago. Extending eastwards from the two mountains for some 450 miles, an ice-barrier is shown, rising to a height of about 200 feet and barring all access to the interior. At the eastern extremity of the barrier, Ross's chart indicated an "appearance of high land." That was all we knew of this region, until Captain Scott and his companions gave reality to the "appearance of high land," circumvented the great ice-barrier and revealed to us the mysteries that lie beyond. The generally accepted idea was that Ross's ice-barrier was really the steep termination of a great ice-sheet, covering, to a depth of hundreds if not thousands of feet, a land rising southwards towards the Pole; and that flat-topped Antarctic icebergs were fragments broken off the barrier. The various sledge expeditions organized by Captain Scott have proved this conception of the so-called ice-barrier to be erroneous.

When the "Discovery," in January, 1902, reached Cape Adare, on the northeast of South Victoria Land, it skirted southwards along a coast-line rising steeply from the ocean, and already partly known from previous exploration, until it reached the neighborhood of Mount Erebus. Thence it continued its course eastwards along the great Ice-Barrier of Ross, which, it was found, if Ross's observations were correct, had receded southwards about forty miles in sixty years. This barrier extended for about four hundred miles, beyond which the expedition found that Ross's "appearance of high land" resolved itself into an extensive mountainous region, rising to thousands of feet and now named "King Edward VII Land." One of the problems left to solve is, how far this land extends southwards towards the Pole, and whether it continues, coastwards, in an unbroken line till it merges into what is known as Graham Land, where the Swedish Antarctic expedition was at work. Appearances of land have been reported by previous expeditions between King Edward VII Land and Graham Land—or rather Alexander Land, which lies immediately south of Graham Land and may be continuous with it.

From the position taken up by the "Discovery" under Mount Erebus, where she remained until the beginning of 1904, expedition after expedition was sent out, south and west and southeast, for the purpose of exploring what was regarded as the interior of the Antarctic continent. No doubt, the most important and perhaps the most hazardous of these expeditions was that undertaken by Captain Scott himself, accompanied by Lieutenant Shackleton and Dr. Wilson. It extended over more than four degrees of latitude, considerably beyond 82 degrees south, and sights were obtained to beyond the 83d degree. This journey was all the time over ice, whose essentially level surface was only varied by hummocks and crevasses. Another journey made a year later by Lieutenant Royds, over 150 miles in a southeasterly direction, found the ice of the same character as that traversed by Captain Scott and his party. Captain Scott's route was, on the west side, flanked by a high, mountainous country, rising at a comparatively short distance from the edge of the level ice to a height of ten thousand feet, but broken at frequent intervals by inlets of an essentially fjordlike character. As far south as could be seen from the furthest point reached, this mountainous land continued, rising at one point—Mount Markham—to fifteen thousand feet. Two journeys were made to the west of the "Discovery's" position, first by Lieutenant Armitage, and later by Captain Scott, to a distance of some two hundred miles from the coast, over ground again of a markedly mountainous character. In the southern journeys, the members of the expedition themselves have no doubt that they were travelling over sea ice which was steadily on the move northwards. In this opinion they were confirmed by the fact that, in boring down through the ice, after a certain depth was reached the temperature began to rise, indicating the proximity of water. What is the depth of this ice it is impossible to say, but it is probably many hundreds of feet. The face of the Barrier itself rises in places to over 200 feet above the sea, while soundings taken immediately in front of the Barrier varied from 300 to over 400 feet. It seems fair to conclude, therefore, that there is a vast mountainous region extending southwards from Cape North, close on 70 degrees, to beyond Mount Markham, close on 84 degrees. Nearly along the 78th parallel, westwards for 200 miles from McMurdo Sound, the land continues to extend and has the same characteristics.

The problem to solve in this direction is, what area is covered by this land. Does it extend right round continuously from 170 degrees east to the meridian of Greenwich? Dr. Drygalski, from his winter quarters on the edge of the Antarctic Circle at about

90 degrees east, made a series of sledge journeys to the land in his vicinity on the south, and seems disposed to conclude that there is a continuous stretch of coast from Knox Land on his east to Kemp Land and Enderby Land on his west, a distance of some 200 miles. Though probable enough, this requires confirmation by actual exploration. Between Cape North and Mount Gauss, opposite the winter quarters of the German Expedition, the expeditions of sixty years ago indicated patches of land, though the real character of what was seen is extremely doubtful. At any rate, that there exists a vast mass of mountainous land extending westwards from the 170th degree of longitude there can be no doubt, and its great extent and mountainous character would indicate that it is more continental than insular.

Another geographical problem is the extent to which the sea under the thick ice-covering on which Scott and Royds made their sledge journeys, extends towards the Pole. Certain authorities are disposed to believe that it goes right through across the Pole and out at the other side, separating this mountainous western land from any other land on the east, which may or may not be continuous with King Edward VII Land. Captain Scott, however, is disposed to conclude that this sea is only an intrusion southwards into a vast land mass, and that it may end about 84 degrees south. In that case it is probably only a great bay or gulf, stretching Polewards and separating Victoria Land from King Edward VII Land, these two lands meeting at about 84 degrees south and hindering the sea from intruding further. That, again, is another problem which can be solved only by actual exploration. How far the fjordlike openings which break what we may call the east coast-line of Victoria Land, extend into the interior, it is impossible to say. They are all filled by enormous glaciers, and these glaciers might very well rest on the beds of actual fjords, which in a more genial climate would be filled with water.

Dr. Nordenskiöld, on the opposite side of the Antarctic area, carried out a certain amount of sledging work, which enabled him to extend our knowledge of Graham Land, and to indicate that this land, instead of being a broken series of islands, extends continuously from about 63 degrees south, probably to about 70 degrees. Whether it joins on to Alexander Land, still further south, and so continues round, with a more or less broken coast-line to King Edward VII Land, remains to be discovered. Mr. Bruce, the leader of the Scottish expedition, was at work some 600 miles to the east of the Swedish expedition. His sphere was in what is known as the Weddell Sea, where he proved that the greatest depth did not much exceed 2,000 fathoms, and that Weddell was mistaken, some eighty years ago, in carrying it down to 4,000 fathoms. His soundings, however, shallowed very rapidly, until in about 74 degrees south and 20 degrees west he discovered a great ice-barrier which he believes to be part of the coast-line of the Antarctic continent. The character of this ice-barrier is quite different from that which was met with by Captain Scott on the other side; for Mr. Bruce assures us that immediately behind the barrier rose rapidly up a great ice-covered land. What are the relations of this land to Graham Land on the west, to Drygalski's supposed extensive coast-line on the east, and to the mountainous land which Scott believes to extend from about 84 degrees south across the Pole, is another problem which we may be assured will not remain unsolved. But it is clear that all four expeditions had to deal more or less intimately with what, as had been conjectured, is probably a great continent of a prevailingly mountainous character, though it may possibly be found that the continental area is broken up into two or more sections by intrusions of the sea. It would not be surprising if it turned out to be essentially a vast land area, in shape not unlike that of Australia.

Such, then, are some of the leading geographical results of the three years' exploration. Whatever may be the extent of the land round the South Pole, it is evident that its interest can only be purely scientific. Its conditions are more hostile to human occupation than any other land that we know on the face of the globe. Of terrestrial animal life there is absolutely none, except it may be a microscopic insect. The millions of penguins that swarm along the coast during the summer season are essentially migratory. But, with the seals, four kinds of which are also abundant, they can be turned to various economic uses by humanity. Nothing but the lowest form of moss is found on the land in the shape of vegetation. The sea is comparatively rich in fishes of various kinds, some of them of great scientific interest, and both Mr. Hodgson of the "Discovery" expedition, and Mr. Bruce of the Scottish expedition, have brought home a rich harvest in this department. Except on the voyage down from New Zealand, and on the voyage homeward from New Zealand across the Pacific to Cape Horn, where a considerable number of deep-sea soundings were made, the soundings of the "Discovery" expedition were mainly along the face of the ice-barrier. Nor had they much opportunity for dredging in the Antarctic proper. Mr. Bruce, however, made this the principal object of his expedition, and his soundings and dredgings in great depths will without doubt prove of great scientific value.

It need hardly be said that, as a whole, all the expeditions found the land deeply covered with ice,—how deep in some cases it is impossible to say, it may be thousands of feet. Still, in Victoria Land, at least, there is a considerable area of rock surface bare of ice, giving an opportunity for the geologist to investigate the nature of the rocks and to collect specimens. Although Mount Erebus is the only steadily active volcano at present known, there is evidence all over the land, so far as could be seen, of widespread volcanic activity in the past. Basalts and the most ancient rocks are everywhere seen, though in the region investigated by the British expedition there were great exposures of sandstone, sometimes overlaid and underlaid by basaltic intrusions. It was in one of these exposures that Mr. Ferrar, the geologist of the "Discovery," came across some fossil plants, a very clear indication that, whatever their nature, the climate of this forbidding land must, at no very remote geological period, have been comparatively genial, temperate, at least, if not approaching the subtropical. When these fossils have been investigated, it will be possible to say whether they are of the same nature as the Cycads found by Dr. Nordenskiöld in Graham Land. Dr. Nordenskiöld's plants belong partly to the Jurassic, and partly to the Tertiary, period. Associated with these are the remains of some vertebrate animals, and, although the region investigated by him lay far to the north of that at which the British expedition was at work, still its climate to-day is essentally Antarctic.

With regard to the present glaciation of the Antarctic Continent, widespread and deep as it is, the observations both of the British and of the German expeditions indicate clearly that, if not actually receding at the present time, it was once much more widespread than it is now. It has already been pointed out that, since Ross's expedition, sixty years ago, the ice-barrier has receded southwards some forty miles. Whether this has any relation to the shrinking of the ice-covering on land, one cannot say in the present state of our knowledge, nor whether the shrinkage of the ice on land is permanent, indicating the approach of a milder climate, nor whether it is simply a case of oscillation such as is found in other glaciated regions of the globe. The comparatively small snowfall, as observed by Captain Scott, may have some relation to this shrinkage.

When completely worked out—and that will not be until some considerable time has elapsed—the meteorological results of the recent Antarctic campaign, and especially of the British expedition, cannot fail to be of immense value, not only from the point of view of pure science, but in those practical applications of meteorology which have to do with the climatic condition of the globe. There have been accumulated, over two years, daily (in some cases, hourly) observations at the "Discovery's" winter quarters, besides those which have been taken on the various sledge expeditions. The trying conditions under which these observations had to be taken, it is difficult for those who live in temperate climates to conceive: and it therefore reflects the highest credit on Lieutenant Royds and the others who had charge of this department that the results have been so abundant and so satisfactory. Probably the lowest temperature on record was experienced, 67.7 degrees, Fahrenheit, below zero—that is, almost a hundred degrees of frost. On the other hand, a temperature as high as 42 degrees, Fahrenheit, was recorded, just about Antarctic midsummer. Hurricanes, the wind sometimes driving at 85 miles an hour, were frequent enough, but there were many days also of unclouded sunshine. The prevailing winds at the "Discovery's" quarters were east and southeast; west winds brought blizzards and storms; and, curiously, south winds, that is winds direct from the Pole, usually raised the temperature as much as 40 degrees. This some try to account for by maintaining that the sea extends right across the Pole to the other side; but, if so, it must be a sea which is practically permanently covered with ice. Lieutenant Royds, who has evidently devoted great care to the meteorology, is convinced that these south winds are of the nature of föhn, a type of wind rising from a low level over a high mountain region, thereby parting with its moisture, and descending on the other side as a dry wind with an increasing temperature. This is a probable enough solution, though these south winds in the Antarctic generally brought snow. There were many displays of the Aurora Australis, but these were never so brilliant as those of the Aurora Borealis.

The meteorological observations taken by the British Antarctic expedition will be greatly enhanced in value when compared with those of the other three expeditions. Although the Scottish expedition was specially intended for oceanic work, its first task was to erect magnetic and meteorological observations on the South Orkneys, which, although somewhat outside the Antarctic Circle, are essentially Antarctic in climatic conditions. These observations have been at work ever since the beginning of 1903, and they will continue at work under the auspices of the Argentine Government; the results thus secured must prove of the highest service. Neither the Scottish nor the Swedish expedition (the latter in Graham Land) obtained anything like so low temperatures as the British expedition; 75 degrees of frost was about the lowest, while the highest temperature obtained by the Swedish observers — curiously, in August (midwinter) — was 48.74 degrees, Fahrenheit. The Swedish expedition fared much worse than the British party in the matter of storms, which were almost continuous and in many cases of the most extreme violence. On Graham Land the southwest winds are the most common and the strongest, and bring the worst weather, though, as a matter of fact, storms came with nearly every wind. At the station of the German expedition, easterly winds prevailed, as at the "Discovery's" quarters, while the southerly winds coming over the vast, uniform, but slightly inclined surface of the inland ice were also of a föhnlike character.

Perhaps, to many, the magnetic results obtained by the various expeditions will be more interesting than any other, dealing with a mysterious force of the real nature of which we are almost entirely ignorant. The magnetic observations made on board the various ships will, no doubt, prove of service to the navigation of the seas between South America, Africa and Australia, which hitherto has been fraught with danger owing to our ignorance of the factors which influence the mariner's compass in those latitudes. The expedition's magnetic work was of the first importance. The definite determination of the South Magnetic Pole is one of the great problems to be solved; but the solution can only be reached when the hundreds of observations made daily are plotted and compared and coordinated and worked out by experts. But it is noteworthy that, when Captain Scott was on his western excursion, he found the compass one day point directly to the South Pole; this was in 156 degrees east longitude and about 78 degrees south latitude. This must mean that the South Magnetic Pole lies somewhere between the point of observation and the South Pole. One theoretical conjecture had placed the South Magnetic Pole about 112 degrees east. The great German physicist, Gauss, conjectured that it lay about 152 degrees east and about 73 degrees south, or about 20 degrees further east than the position assigned to it by Dumont D'Urville; while, according to Ross, it was in about the same longitude as that assigned to it by Gauss, but some three degrees of latitude farther south. From the observations collected by the various expeditions, all these conjectures ought to give way to certainty, and so a scientific point of the first importance be finally settled.

These, then, are some of the results which, at the present stage, we can say have been achieved by the various expeditions. The numerous photographs brought home — the British expedition alone has considerably over two thousand—and the exquisite water-color sketches, hundreds of which have been made by Dr. Wilson, of the scenery and life of the region, will give a fair idea of the outward condition, at least, of this still imperfectly known land. On all sides, except probably towards the south point of America, surrounded by the deep ocean, it is truly continental in character; broken up, it may be, into two great masses, though probably these are not entirely severed. The fossils obtained and the geological conditions observed may afford material for concluding whether or not, at a past geological period, the Antarctic continent was continuous with South America and extended as far as New Zealand, as has been boldly conjectured by Prof. J. W. Gregory; indeed, New Zealand has quite the appearance of a fragment broken off from South America. But these are only some of the intensely interesting questions suggested by the vast harvest of results secured during the recent international campaign in the South Polar area,—results which fully justify the expenditure of money and the endurance of great hardships. Happily, the loss of life has been comparatively small.

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